Time Integrated Indoor Air Sampling using a Membrane Based Passive Sampler

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Goal: Evaluate Human Risk Evaluate presence of VOC/SVOCs throughout the home

Challenges include:

- 1. Heterogeneous system
- 2. Intermittent contaminant signal
- 3. Active home

The longer the sampling the time the more representative of potential exposure

Unobtrusive long term sampler



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Time Integrated Sampler

- Problem short term sampler
 - Snap shot rather than realistic exposure picture
 - Active sampling complex and intrusive

- Solution Membrane based passive sampler
 - -Long term sampling realistic exposure
 - -Simple to use and unobtrusive



Courtesy of Severn Trent Laboratories









Tool: GORE[®] Module – Passive Sampler

GORE[®] Membrane (ePTFE)

- Waterproof, vapor permeable
- Chemically-inert
- Protects sample integrity
- Engineered sorbents (inside the membrane)
 - Hydrophobic



GORE-TEX® Membrane Vapors pass through Water & soil particles remain outside Adsorbents Worldwide

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Passive Sampling

- Traditional:
 - Site screening
 - Semi-quantitative
 - VI Line of evidence
- New application:
 - Risk evaluation using concentration values





Calculating Concentrations



S=sampling rate vol/t



 $C_{X} = \left| \left(\frac{1}{S} \right) \left(\frac{dm}{dt} \right) \right|$

m = mass

t = time

 $D = diffusion \ coefficient$

(A/L) = geometric parameter describing shape of sampler

Cx = concentration of analyte in the module at time, t = x

Co = concentration at time, t = 0



Determining Sampling Rate, S



Worldwide

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Toluene Sampling Rate



Creative Technologie Worldwide

Determining Sampling Rate, S



Uptake rates are independent of: -Temperature -Relative humidity -Air flow rate



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24 Hour Air Sampling Trial





Testing in Homes

- Four samplers hung in several area
 - Basements
 - Bedrooms
 - Family rooms
- One module removed after 1, 3, 5, and 7+ days
- TO17 comparative sampling four homes
 24 to 36 Hours



Sampling – 24 to 180 hours





TO-17Comparative Sampling (24–36 Hrs)



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Results – Mass Uptake m,p-Xylene, 1,2,4-TMB, Naphthalene



Results – Mass Uptake Benzene, Toluene & PCE





Associates

4 Homes

Low MW

High MW

Compound	R^2	Conc.,ug/m^3
Benzene	<0.1	0.73
	0.75	0.74
	<0.1	0.9
	<0.1	2.22
Toluene	0.782	3.31
	0.804	3.35
	<0.1	14.17
	<0.1	50.2
m,p-Xylene	0.754	0.78
	0.992	1.25
	0.807	10.8
	0.915	31.1
1,2,4-TMB	0.971	0.5
	0.884	0.7
	0.996	1.74
	0.996	6.36
Naph	0.999	0.32
	0.997	0.58
	0.971	0.63
	0.951	0.75



Concentration Comparisons by Compound



Observation

S

- 24 Hour Home Sampling
 - Good correlation for broad range of compounds
- One to Seven Day Sampling
 - Correlation improved with shorter sampling period
 - Best when active and passive sampling times similar
 - Overall correlation better with higher MW compounds



Questions to Answer



 Did air concentrations for lighter MW compounds decrease over sampling period?

or

 Does sampler have higher capacity for heavier compounds?



Test Plan

- Passive samplers set out for 4 Days
- 24 hour samples taken for each of 4 day period
- Compare mass of 4 day samples with sum of 1 day samples
- Calculate concentrations for each sampling event
- ✓ If mass of 4 day sample = sum of 1 day samples
 - uptake is constant and unaffected by higher MW compounds
- ✓ If mass of 4 day sample doesn't equal sum
 ➢ rate changed over time

✓ If each 1 day sample conc. similar

> constant air conc.

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Target Compounds Detected Low MW

- Toluene
- Ethylbenzene
- Xylenes
- Octane (C8)
- Tetrachloroethen

<u>High MW</u>

- •Undecane (C11)
- •1,2,4-Trimethyl benzene
- Naphthalene
- 1,4-Dichlorobenzene

Compounds found in each sampling event above reporting limit of 0.05ug



e

Results – Mass Comparisons, ug



Results - Concentration Comparisons



- •Minimal variability over 4 days
- •Significant low bias on lower MW compounds

W. Derress bias on higher MW compounds



Changing Air Concentrations?





– Did air concentrations change over time or did uptake change rate change?

Concentrations remained fairly constant

– Does sampler have higher capacity for heavier compounds?

Uptake changed for lower MW compounds indicating approaching equilibrium



Conclusions

- Good method for unobtrusive indoor air sampling
- Provide concentration results for risk analysis
- Sampling best for up to 24 hours for low concentration of low MW compounds Future Investigations
 - Use adsorbents with greater capacity for low MW compounds



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